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AUTHOR	Perez, Christina
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ABSTRACT

This article discusses the issue of equity in standards-based elementary mathematics classrooms. It is argued that while some of the gaps in mathematics achievement have slowly diminished (e.g., differences in mathematics grades and participation rates between girls and boys in K-12 education have decreased), others remain intractable. Other sections in the article discuss the fact that stereotypes begin in the primary grades, solutions in the standards-based classroom, cooperative groups, and inquiry-based learning. (MM)

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Weaving Gender Equity into Math Reform

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Equity in Standards-based Elementary Mathematics Classrooms

by Christina Perez

In 1989 the National Council of Teachers of Mathematics (NCTM) articulated the goal of "mathematics for all" in its *Curriculum and Evaluation Standards for School Mathematics* . Embedded in this idea is the goal of eliminating the long-standing disparities in mathematics achievement between girls and boys, between White students and students of color, and between the economically disadvantaged and the advantaged. These disparities, which begin early in a child's education, influence the choices available to that child for the rest of his or her life: "Mathematics has become a critical filter for employment and full participation in our society" (NCTM, 1989). Eleven years later, the concerns laid out in the Standards still remain a pressing issue for American schools.

The state of education has certainly changed from what it was in 1989. Nevertheless, the concerns laid out in the *Standards* still remain a pressing issue for American schools, and educational equity has moved to the forefront in NCTM's new *Principles and Standards for School Mathematics* (2000).

While some of the gaps in mathematics achievement have slowly diminished (e.g., differences in mathematics grades and participation rates between girls and boys in K-12 education have decreased), others remain intractable.

On the 1996 National Assessment on Education Progress (which uses a framework influenced by the NCTM *Standards*), males outperformed females in grades four, eight, and twelve, with more males than females scoring at the "proficient" and "advanced" levels of achievement. White students were more apt to score at "proficient" and "advanced" levels than were students of color (with the exception of Asian/Pacific Islander students). In addition, students not eligible for the free/reduced lunch program tended to score higher at all three grade levels than their peers who participated in the program (National Center for Education Statistics, 1996).

Results from the SAT-Math test parallel these trends. In 1999 males scored 35 points higher on average than females. White students scored almost 100 points higher than Black students and 70 points higher than Hispanic students (College Board, 1999).

The trend continues at the college level. In 1995, despite the fact that women outnumber men in college, only 17 percent of bachelor's degrees in engineering were awarded to women of all races; for math/computer science the total was a somewhat higher - 35 percent (Campbell and Clewell, 1999). That same year, Blacks and Hispanics (at 22 percent of the total U.S. population) only earned a total of 12 percent of all bachelor's degrees in

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science, mathematics, and engineering (National Science Foundation, 1999).

Stereotypes begin in the primary grades
As early as second grade, both boys and girls express gender stereotyping by describing math as a male domain. By third grade, females, in comparison with males, rate their competence in mathematics lower - even when they receive the same or better grades. By sixth grade, girls see mathematics as less important and useful to career goals than boys do (Hanson, 1992).

Teacher practice contributes to the continuation or elimination of these patterns. Some of the most commonly cited research shows that teachers of all grade levels tend to call on boys more often than girls, ask them more complex questions, provide them with more analytical feedback, and attribute their success to ability. Teachers more often think girls succeed in math because they try hard. The first three patterns also hold true for teachers' interactions with White and non-White students (Grayson and Martin, 1997).

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Solutions in the standards-based classroom
Standards-based curricula include several teaching methodologies and mathematical content strands not typically found in traditional elementary math classrooms. Students frequently work in cooperative groups. They are encouraged to create their own strategies for solving problems and to be able to use multiple strategies. Data analysis, math of change, and geometry are emphasized. The teacher's role shifts from one who gives information to a more facilitative approach. Communication of mathematical concepts through multiple avenues (drawing, graphs, journals, dialoguing with peers, etc.) is integral. Conceptual understanding, rather than focusing on math facts, is valued.

Many of these changes reflect the NCTM's commitment to making mathematics accessible to all students. The techniques allow students to learn at their own pace and in their own style, getting at the root of what educational *equity* is all about. Approaching the classroom with equity in mind means thinking about what each student needs to further her mathematical understanding and providing the support for that to happen.

This is very different from the notion of educational *equality*, which is focused on providing all students with the same thing. Having all students on the same page at the same time fits more closely with the approach of traditional mathematics curricula--and often ends up reaching only those students in the middle. In standards-based classrooms, the teacher as the facilitator of learning has the opportunity to reach all students.

Curriculum alone, though, is not enough to close the gaps in achievement among students. The curriculum provides the supports for the mathematical content, but it is the teacher who must decide how to facilitate the learning of the material. Therefore, there are equity issues specific to standards-based mathematics classroom that teachers should consider.

Cooperative Groups

In theory, cooperative groups promote educational equity by giving each student in the classroom a chance to participate actively. But it is up to the teacher to construct groups that offer a non-threatening environment for students to explore mathematics. This factor can be particularly beneficial to students who may feel intimidated speaking in front of the whole class.

When organizing cooperative groups, teachers need to consider several criteria. Gender, race, language of origin, problem-solving strategy, and mathematics ability are among the most important. The combination of these factors, along with the added layer of considering children's personalities and other social factors, requires teachers to think carefully about the groupings and to reorganize them frequently to meet students' changing needs.

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Rather than always relying on one method for grouping students, teachers should employ a variety of strategies. At times groups should be homogeneous (pairing students of the same ability, language, and gender together); at other times groups should be heterogeneous (placing students of different abilities, races, and gender together).

Having a gender balance in cooperative groups has been shown to be particularly beneficial to girls. One research study demonstrated that in groups of four, if there are three boys and one girl, or three girls and one boy, most of the interactions (questions, problem-solving, hands-on activities, and so on) are directed toward boys (Webb, 1984). The girls in those groups lose out on some of the most substantive mathematics learning. When the groups consisted of two females and two males, the interaction patterns were more evenly distributed.

At times placing students of various ability levels together is most appropriate. Students who understand a mathematics problem can help others who may be struggling while simultaneously verifying their own thinking. In mixed groups, students using invented or alternative algorithms can share their strategies, providing group members with new ways to solve problems. At other times grouping students of similar abilities together is preferred since this enables all students to work at a pace that is comfortable to them.

Similarly, placing students with different language backgrounds together supports both students who understand the math content but struggle with English as well as those who speak English but need more assistance with the mathematics. Alternatively, pairing students who speak the same language allows students to delve deeper into the mathematics without having to also translate language.

Inquiry-Based Learning

Another key component of standards-based curricula is a commitment to inquiry-based learning. Rather than relying on the teacher to tell them how to solve a math problem, students must find their own strategies. This method encourages risk taking, problem solving, and a deeper understanding of mathematical concepts.

Again, the teacher's important task is to consider differences in learning styles and how various styles interact with inquiry-based learning.

For example, one recent research study of first through third grade classrooms revealed gender differences in problem-solving strategies for addition and subtraction problems. The teachers in the study were part of a three-year professional development program. Though no specific curriculum was used, students learned standard algorithms and also had an opportunity to invent their own. Results from the study showed that girls tended to use tried-and-true approaches like counting with concrete objects while boys were more apt to use invented algorithms. For subtraction in particular, 80 percent of boys used invented strategies, compared to only 45 percent of girls. A link was also shown between boys' use of invented strategies and their greater success at solving more difficult problems (Fennema, et al, 1998).

This study supports the approach of encouraging children to invent their own algorithms by showing how this can lead to higher levels of mathematical thinking (as seen in boys' success rates). But if girls are not using invented strategies, then they may be locked out of higher levels of learning. Here are a few ways to address this disparity:

- Look in your own classroom to see if these differences exist. Do girls tend to stick with more basic strategies while boys tend to try new or more complex approaches?
- Stretch students' thinking by asking them to show multiple ways to solve a problem.
- Pair students who tend to use invented strategies with those who have a narrower repertoire of approaches. Have each student explain his or her method for solving

the problem so that each student can build on the other's thinking.

- Encourage girls to be confident using multiple strategies. One theory behind the differences in problem solving strategies posits that girls are taught to "play it safe" and not take risks, whereas boys are encouraged to step outside of the rules. This reliance on what's safe could lock girls into using mostly counting or teacher-taught standard algorithms instead of challenging themselves with alternative strategies. Activities involving estimation, hypothesizing, and multiple ways to solve a problem all support risk taking. By showing girls (and all students) that it's OK to take chances, make mistakes, and succeed in math, teachers can promote students' confidence and risk taking.

Built in to the standards-based math curricula are some answers to the question of how to eliminate the achievement gaps in mathematics. But curriculum content alone is not the answer. Varying the composition of cooperative groups and attention to students' problem solving strategies provide two ways to delve deeper into classroom practice in order to ensure an equitable learning environment.

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